Study of Electrical Stimulation Using Photoelectric Dye-coupled Films

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The aim of this study was to evaluate the effect of a photoelectric dye-coupled polyethylene film on bone formation, as a new application technique to activate osteogenesis in dentistry. Photoelectric dye was coupled with polyethylene films through amide linkages, which absorb light and convert photon energy to electric potentials. Histological investigation of bone formation following the electrical stimulation by photoelectric dye-coupled films with visible light irradiation was conducted.

In this study we used the photoelectric dye NK-5958 (3-(carboxymethyl)-2-[2-[4-(dimethylamino) phenyl]ethenyl]-naphtho[2,1-d]thiazolium bromide.

The dye was coupled with a polyethylene film through amide linkage. Carboxyl moieties were introduced to the polyethylene film surface by reacting with 97% fuming nitric acid at 78℃ for 18 min in a flask. Then, the carboxyl moiety-bearing film underwent amide linkage through the formation of ethylene-diamine bonds between carboxyl moieties of the film and dye in the catalytic presence of dicyclohexylcarbo-diamide in a reaction solvent, chlorobenzene, at 35℃ for 24 hours. The dye-coupled film was finally washed with chlorobebzene. These chemical processes were monitored by infrared and visible light absorption spectra to confirm successful reactions.

Osteoblast-like cells isolated from newborn rat calvaria using sequential enzyme digestion were applied to an *in vitro* experiment. The cells were cultured on dye-coupled films or dye-uncoupled plain films and irradiated with visible light (diode laser, wavelength : 532 nm, power dose : 2.0 mW/cm^2, 10 min/day) for 3 days. After the cell culture, the number of cells was counted to evaluate the effects of the electric stimulation on cell proliferation.

The proliferation of osteoblast-like cells cultured on dye-coupled films was promoted by electrical stimulation, and the number of cells was much greater than that of cells cultured on dye-uncoupled films.

These results indicate that photoelectric dye could be coupled to a polyethylene film, and this dye-coupled film combined with visible light irradiation could induce the proliferation of osteoblast-like cells.

Key words : photoelectric dye, electric stimulation, bone formation

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